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Indian Standard

BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART 9 ACCELERATION (STEADY STATE) TEST

UDC 621·38·038+621·31 : 620·199

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 4 *July* 1984

Indian Standard

BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART 9 ACCELERATION (STEADY STATE) TEST

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*Dr P. K. Dutta was the convener for the meeting in which this standard was finalized.

Indian Standard

BASIC ENVIRONMENTAL TESTING PROCEDURES FOR ELECTRONIC AND ELECTRICAL ITEMS

PART 9 ACCELERATION (STEADY STATE) TEST

0. FOREWORD

0.1 This Indian Standard (Part 9) was adopted by the Indian Standards Institution on 5 March 1984, after the draft finalized by the Environmental Testing Procedures Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

0.2 The differences in environmental testing procedures for component type items and equipment type items are fast disappearing in the context of technological developments. It is, therefore, found necessary to have uniform testing procedures wherever possible. This series of standards on environmental testing procedures (IS : 9000) has been prepared with this objective. This is also in line with the principle adopted by IEC/TC 50 ' Environmental testing in developing unified series of standards on environmental testing procedures ' by International Electrotechnical Commission.

0.2.1 It is proposed to withdraw the existing Indian Standards, namely, IS : 589-1961* and IS : 2106† series dealing with environmental tests for electronic components and equipment respectively, as soon as the tests mentioned therein are covered in the new series (IS : 9000).

0.3 This standard shall be read in conjunction with IS : 9001 (Part 15)-1984‡.

0.4 This standard is largely based on IEC Pub 68-2-7 (1968) ' Basic environmental testing procedures for electronic components and electronic equipment, Part 2 : Tests - Test Ga : Acceleration, steady state ', issued by the International Electrotechnical Commission (IEC).

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*Basic climatic and mechanical durability tests for components for electronic and electrical equipment (*revised*).

†Environmental tests for electronic and electrical equipment.

‡Guidance for environmental testing : Part 15 Acceleration (steady state) test.

0.5 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 This standard (Part 9) deals with the test procedure for acceleration (steady state) test for electronic and electrical items as part of the basic environmental testing procedures.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions and explanation of terms given in IS : 9000 (Part 1) - 1977† shall apply.

3. OBJECT

3.1 The object of this test is to prove the structural suitability and the satisfactory performance of components and equipments when subjected to forces produced by steady acceleration enviroments (other than gravity), such as, occur in moving vehicles, especially flying vehicles, rotating parts and projectiles, and to provide a test of structural integrity for certain components.

4. GENERAL

4.1 Equipments or components destined to be installed in moving bodies will be subjected to forces caused by steady accelerations. Naturally, such an environment is most pronounced in flying vehicles and rotating machinery, although in certain conditions accelerations in land vehicles may be of significant magnitude.

4.2 In general, the acceleration encountered in service have different values along each of the major axes of the moving body and in addition, usually have different values in the opposite senses of each axis.

4.3 If the attitude of the item is not fixed with regard to the moving body, then the relevant specification should prescribe a level, which may be applied along each of the major axes and senses of the item, having taken into account the maximum accelerations in different axes of the moving body.

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*Rules for rounding off numerical values (*revised*).

†Basic environmental testing procedures for electronic and electrical items : Part 1 General.

5. CONDITIONS FOR TESTING

5.1 Characteristics of the Test Apparatus

5.1.1 *General* — Acceleration conditions are applied by means of a centrifuge where the acceleration is directed towards the centre of the rotating system. In certain special cases, however, the item may be sensitive to gyroscopic couples, and it may only be possible to perform the test by using a machine capable of applying linear acceleration, in which case the relevant specification should state this requirement.

The centrifuge shall have the provision of slip rings for providing electrical connections to the item under test.

5.1.2 *Tangential Acceleration* — When increasing the rotational speed of a centrifuge from zero to the value necessary to achieve the specified acceleration, or when decreasing back to zero, the machine should be so controlled that the item is not subjected to a value of tangential acceleration greater than 10 percent of the specified steady acceleration.

5.1.3 *Acceleration Gradient* — The dimensions of a centrifuge relative to the item shall be such that no part of the item, other than flying leads, shall be subjected to a value of acceleration outside the tolerance given in **5.1.4**.

5.1.4 *Acceleration Tolerance* — If the linear dimensions of the item are less than 10 cm, the acceleration on all parts of the item (excluding flying leads) shall be within ± 10 percent of the specified steady state acceleration.

In other cases, the acceleration on all parts (excluding flying leads) shall be within the limits − 10 percent + 30 percent of the specified steady acceleration.

5.2 Mounting — For mounting, reference may be made to IS : 9001 (Part 12)-1977*. The item shall be mounted on the acceleration machine either directly or by means of suitable fixtures. These fixtures should be such as to enable the item to be subjected to acceleration forces in the direction or directions required by the relevant specification. Generally, these directions will be the two opposite senses of three mutually perpendicular axes.

External connections necessary for measuring purposes should add the minimum restraint and mass.

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*Guidance for environmental testing: Part 12 Mounting of electronic and electrical items for dynamic tests.

NOTE — For reasons of safety, care should be taken to prevent the item under test from being thrown off if the mounting attachments are broken, but any safety devices used should not introduce additional constraint during the test.

5.2.1 *Mounting of Components* — If the component is provided with specific means of mounting, these shall be used as prescribed in the relevant specification, and any additional restraining straps should be avoided, wherever possible. For severities from 200 000-300 000 m/s^2, suitable protection should be provided for component terminations.

The mounting of components, not provided with unique means of mounting, shall be such that the test conditions applied should dynamically load the body and/or its terminations. Either the body and the terminations or the terminations only, may be clamped, as specified by the relevant specification.

Components with axial terminations weighing less than 15 g shall be secured to rigid pillars leaving 5 to 8 mm between the point of emergence of the terminations and the pillars. Similar components weighing 15 g and more shall be clamped so as to avoid any stress on the terminations

External connections made to components for power supply and measurements shall add a minimum of mass and place a minimum of restraint on the components.

5.2.2 *Mounting of Equipments* – The equipment shall be fastened to the centrifuge by its normal means of attachment using isolators, if appropriate, or as prescribed in the relevant specification. Any additional stays or straps should be avoided, wherever possible.

If cables, pipes, etc, are required to be connected to the equipment during the test, as prescribed in the relevant specification, these should be so arranged as to add similar restraint and mass as in the normal installation.

6. SEVERITY

6.1 Components — The relevant specification shall prescribe an acceleration value for the test, chosen, where possible, from the standard values listed below. It shall also prescribe the angle, with respect to the axes of the item, at which this acceleration is to be applied, where this is necessary.

NOTE — The value prescribed for the acceleration should take into account the purpose of the test, whether it is to be made for checking the structural integrity of the item or to assess the ability of the item to withstand the forces occurring in moving vehicles or rotating machinery.

The standard levels of test (acceleration 3 m/s^2) are given below:

50
100
170
200
500
1 000
2 000
5 000
10 000
20 000
50 000
100 000
200 000
300 000

6.2 Equipment — The severities for equipment shall be chosen from Table 1 for equipment subjected to normal acceleration or Table 2 for equipment subjected to crash condition acceleration.

7. INITIAL MEASUREMENTS

7.1 The item shall be visually examined, and electrically and mechanically checked, as required by the relevant specification.

8. CONDITIONING (PROCEDURE FOR TESTING WITH A CENTRIFUGE)

8.1 Unless otherwise stated in the relevant specification, the acceleration conditioning shall be imposed in both senses of three mutually perpendicular axes in turn, which shall be the three major axes.

8.2 The items shall be mounted on the centrifuge as given in **5.2**. The centrifuge shall be rotated at the speed necessary to produce the specified acceleration level(s)/class(es) as given in **6.1**, Tables 1 or 2 as required.

8.2.1 The equipment which may be mounted in any attitude in the aircraft shall be subjected to the appropriate resultant acceleration given in Tables 1 or 2 depending upon the severity chosen. The equipment which may be mounted in one fixed attitude in the aircraft shall be subjected to the appropriate acceleration applied in each of the *X*, *Y* and *Z* axes and senses as given in Tables 1 or 2 depending upon the severity chosen.

8.3 The necessary speed of rotation shall be maintained for not less than 10 s or for a period stated in the relevant specification.

8.4 The relevant specification shall prescribe which of the following conditions of functioning or survival has to be satisfied and the corresponding acceleration level(s):

a) Item to function within the performance limits given in the relevant specification.

b) Item not to suffer any permanent derangement, but need not function;

c) Item to function, but not necessarily within the performance limits, but should suffer no permanent derangement; and

d) Item not to break loose, although it may be permanently damaged or deranged.

8.5 The relevant specification shall prescribe the order in which the checks given in **8.4** are to be applied.

9. FINAL MEASUREMENT

9.1 The item shall be visually examined, and electrically and mechanically checked, as required by the relevant specification.

10. INFORMATION TO BE GIVEN IN THE RELEVANT SPECIFICATION

10.1 When this test is included in the relevant specification, the following details shall be given as far as they are applicable :

	Clause Reference
a) Type of test apparatus	5.1
b) Method of mounting components	5.2.1
c) Method of mounting equipments	5.2.2
d) Special mounting requirements, if any	5.2
e) Normal acceleration or crash conditions acceleration, in case of equipment	6.2
f) Acceleration level(s)/class(es)	6.1, 6.2, Tables 1 and 2
g) Axes and direction of acceleration	8.1, 8.2.1
h) Initial measurements	7
j) Duration of conditioning	8.3
k) Conditions of functioning or survival	8.4
m) Order of checks	8.5
n) Final measurements	9
p) Any deviation from the normal test procedure	

TABLE 1 ACCELERATION CLASSES (NORMAL) AT CG OF AIRCRAFT

(*Clauses* 6.2, 8.2 *and* 8.2.1)

TYPICAL AIRCRAFT	INSTALLATION		TYPICAL MANOEUVRES COVERED	RESULTANT PROOF ACCELERATION	COMPONENTS OF PROOF ACCELERATION (m/s²)			ACCELERATION CLASS
	Position	Attitude			X (*see* Note 1)	Y (*see* Note 2)	Z (*see* Note 3)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Highly manoeuvrable (military) aircaft	Any	Any		170 in any direction	—	—	—	A
		Fixed	Pullout and landing and assisted take off	170	± 90	± 25	− 140	B
			Roll, down gust	170	0	± 140	+ 90	C
	Fuselage*	Any		130 in any direction	—	—	—	D
		Fixed	Pullout, spin, roll	100	± 25	± 20	− 90	E
			Landing and assisted take off	130	± 90	± 25	− 85	F
			Down gust	− 50	+ 10	0	+ 45	G
Other military aircraft and fully aerobatic civil aircraft	Any	Any		70 in any direction	—	—	—	H
		Fixed	Pullout	70	± 25	± 10	− 60	J
			Down gust	40	+ 10	0	+ 35	K
			Roll	50	0	+ 40	− 25	L
	Fuselage*	Any		65 in any direction	—	—	—	M
		Fixed	Pullout	65	± 20	± 10	− 60	N
			Down gust	− 40	+ 10	0	+ 35	P
Military and civil rotorcraft and semi -aerobatic civil aircraft	Any	Any		55 in any direction	—	—	—	Q
		Fixed	Pullout, roll	55	± 20	± 20	− 45	R
			Down gust	− 25	+ 10	0	+ 20	S

NOTE 1 — X represents the longitudinal axis (forward positive, backward negative).

NOTE 2 — Y represents the transverse axis, that is, lateral (starboard positive, port negative).

NOTE 3 — Z represents the normal axis, that is, vertical (downwards positive, upwards negative).

*The fuselage position shall be taken as applying only to equipment within a radius of 1/4 fuselage length from the centre of gravity (CG).

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TABLE 2 ACCELERATION CLASSES (CRASH) AT CG OF AIRCRAFT

(*Clauses* 6.2, 8.2 *and* 8.2.1)

TYPICAL AIRCRAFT	INSTALLATION ATTITUDE	EQUIPMENT LOCATION	MAXIMUM RESULTANT PROOF ACCELERATION (m/s²)	MAXIMUM COMPONENTS OF PROOF ACCELERATION (m/s²)			TEST CONDITION
				X (*see* Note 1)	Y (*see* Note 2)	Z (*see* Note 3)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Military aircraft	Fixed	Where, if it broke loose, it could either injure occupants at their crash stations or prevent the use of emergency equipment or exits.	255	− 250	± 40	0	T
		Where, if it broke loose, it could injure occupants at their crash stations.	110	− 100	± 40	0	U
Civil aircraft	Fixed	Where, if it broke loose, it could injure occupants at their crash stations or prevent the use of emergency equipment or exits.	100	− 90	± 22·5	− 45 + 40	V
Rotorcraft (military and civil)	Any direction	Where, if it broke loose, it could injure occupants at their crash stations or prevent the use of emergency equipment or exits.	60 in any direction	—	—	—	W

NOTE 1 — X represents the longitudinal axis (forward positive, backward negative).
NOTE 2 — Y represents the transverse axis, that is, lateral (starboard positive, lateral negative).
NOTE 3 — Z represents the normal axis, that is, vertical (downwards positive, upwards negative).